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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

TITLE: IMPROVED DOWN HOLE OIL AND GAS
WELL HEATING SYSTEM AND METHOD
FOR DOWN HOLE HEATING OF OIL
AND GAS WELLS

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1 CITATION TO PRIOR APPLICATION

2 This is a continuation-in-part with respect to U.S.
3 Patent Application, Serial No. 10/037,754 filed October 22,
4 2001.

5
6 BACKGROUND OF THE INVENTION

7 1. Field of The Invention

8 The present invention relates to systems and methods for
9 producing or delivering heat at or near the down hole end of
10 production tubing of a producing oil or gas well for improving
11 production therefrom.

12
13 2. Background Information

14 Free-flowing oil is increasingly difficult to find, even
15 in oil wells that once had very good flow. In some cases,
16 good flowing wells simply "clog up" with paraffin. In other
17 cases, the oil itself in a given formation is of a viscosity
18 that it simply will not flow (or will flow very slowly) under
19 naturally ambient temperatures.

20
21 Because the viscosity of oil and paraffin have an inverse
22 relationship to their temperatures, the solution to non-

1 flowing or slow flowing oil wells would seem fairly straight
2 forward -- somehow heat and oil and/or paraffin. However,
3 effectively achieving this objective has proven elusive for
4 many years.

5
6 In the context of gas wells, another phenomena -- the
7 buildup of iron oxides and other residues that can obstruct
8 the free flow of gas through the perforations, through the
9 tubing, or both -- creates a need for effective down hole
10 heating.

11
12 Down hole heating systems or components for oil and gas
13 wells are known (hereafter, for the sake of brevity, most
14 wells will simply be referred to as "oil wells" with the
15 understanding that certain applications will apply equally
16 well to gas wells). In addition, certain treatments
17 (including "hot oil treatments") for unclogging no-flow or
18 slow-flow oil wells have long been in use. For a variety of
19 reasons, the existing technologies are very much lacking in
20 efficacy and/or long-term reliability.

1 The present invention addresses two primary shortcomings
2 that the inventor has found in conventional approaches to
3 heating oil and paraffin down hole: (1) the heat is not
4 properly focused where it needs to be; and (2) existing down
5 hole heaters fail for lack of design elements which would
6 protect electrical components from chemical or physical attack
7 while in position.

8
9 The present inventor has discovered that existing down
10 hole heaters inevitably fail because their designers do not
11 take into consideration the intense pressures to which the
12 units will be exposed when installed. Such pressure will
13 force liquids (including highly conducive salt water) past the
14 casings of conventional heating units and cause electrical
15 shorts and corrosion. Designers with whom the present
16 inventor has discussed heater failures have uniformly failed
17 to recognize the root cause of the problem -- lack of adequate
18 protection for the heating elements and their electrical
19 connections. The down hole heating unit of the present
20 invention addresses this shortcoming of conventional heating
21 units.

1 Research into the present design also reveals that
2 designers of existing heaters and installations have
3 overlooked crucial features of any effective down hole heater
4 system: (1) it must focus heat in such a way that the
5 production zone of the formation itself is heated; and
6 (2) heat (and with it, effectiveness) must not be lost for
7 failure to insulate heating elements from up hole components
8 which will "draw" heat away from the crucial zones by
9 conduction.

10
11 However subtle the distinctions between the present
12 design and those of the prior art might at first appear,
13 actual field applications of the present down hole heating
14 system have yielded oil well flow rate increases which are
15 multiples of those realized through use of presently available
16 down hole heating systems. The monetary motivations for
17 solving slow-flow or no-flow oil well conditions are such
18 that, if modifying existing heating units to achieve the
19 present design were obvious, producers would not have spent
20 millions of dollars on ineffective down hole treatments and
21 heating systems (which they have done), nor lost millions of
22 dollars in production for lack of the solutions to long-felt

1 problems that the present invention provides (which they have
2 also done).

3
4 SUMMARY OF THE INVENTION

5 It is an object of the present invention to provide an
6 improved down hole heating system for use in conditioning oil
7 and gas wells for increased flow, when such flow is impeded
8 because of viscosity and/or paraffin blockage conditions.
9

10 It is another object of the present invention to provide
11 an improved design for down hole heating systems which has the
12 effect of more effectively focusing heat where it is most
13 efficacious in improving oil or gas flow in circumstances when
14 such flow is impeded because of oil viscosity and/or paraffin
15 blockage conditions.
16

17 It is another object of the present invention to provide
18 an improved design for down hole heating systems for oil and
19 gas wells which design renders the heating unit useful for
20 extended periods of time without interruption for costly
21 repairs because of damage or electrical shorting caused by
22 unit invasion by down hole fluids.

1 It is another object of the present invention to provide
2 an improved method for down hole heating of oil and gas wells
3 for increasing flow, when such flow is impeded because of
4 viscosity and/or paraffin blockage conditions.

5
6 In satisfaction of these and related objects, the present
7 invention provides a down hole heating system for use with oil
8 and gas wells which exhibit less than optimally achievable
9 flow rates because of high oil viscosity and/or blockage by
10 paraffin (or similar meltable petroleum byproducts). The
11 system of the present invention, and the method of use
12 thereof, provides two primary benefits: (1) the involved
13 heating unit is designed to overcome an unrecognized problem
14 which leads to frequent failure of prior art heating units --
15 unit invasion by down hole heating units with resulting
16 physical damage and/or electrical shortages; and (2) the
17 system is designed to focus and contain heat in the production
18 zone to promote flow to, and not just within, the production
19 tubing.
20

1 BRIEF DESCRIPTION OF THE DRAWINGS

2 Fig. 1 is an elevational view of a producing oil well
3 with the components of the present down hole heating system
4 installed.

5
6 Fig. 2 is an elevational, sagittal cross section view of
7 the heating unit connector of the present invention.

8
9 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

10 Referring to figure 1, the complete down hole heating
11 system of the present invention is generally identified by the
12 reference numeral 10. System 10 includes production tubing 12
13 (the length of which depends, of course, on the depth of the
14 well), a heat insulating packer 14, perforated tubing 16, a
15 stainless steel tubing collar 18, and a heating unit 20.

16
17 Heat insulating packer 14 and stainless steel collars 18
18 are included in their stated form for "containing" the heat
19 from heating unit 20 within the desired zone to the greatest
20 practical degree. Were it not for these components, the heat
21 from heating unit 20 would (like the heat from conventional
22 down hole heater units) convect and conduct upward in the well

1 bore and through the production tubing, thereby essentially
2 directing much of the heat away from the area which it is most
3 needed -- the production zone.

4
5 Perhaps, it goes without saying that oil that never
6 reaches the pump will never be produced. However, this truism
7 seems to have escaped designers of previous down-hole heating
8 schemes, the use of which essentially heats oil only as it
9 enters the production tubing, without effectively heating it
10 so that it will reach the production tubing in the first
11 place. largely containing the heat below the level of the
12 junction between the production tubing 12 and the perforated
13 tubing 16, as is achieved through the current design, has the
14 effect of focusing the heat on the production formation
15 itself. This, in turn, heats oil and paraffin in situ and
16 allows it to flow to the well bore for pumping, thus
17 "producing firs the viscous materials which are impeding
18 flow," and then the desired product of the well (oil or gas).
19 Stainless steel is chosen as the material for the juncture
20 collars at and below the joinder of production tubing 12 and
21 perforate tubing 16 because of its limited heat conductive
22 properties.

1 Physical and chemical attack of the electrical
2 connections between the power leads and the heater rods of
3 conventional heating systems, as well as shorting of
4 electrical circuits because of invasion of heater units by
5 conductive fluids is another problem of the present art to
6 which the present invention is addressed.

7
8 The patent application which serves as a priority basis
9 for the present invention discloses an embodiment that
10 tremendously increases down hole wiring connection integrity.
11 However, referring to Figure 2, the present invention is even
12 better at preventing the aforementioned electrical problems.
13 In fact, the unique combination of the materials, particularly
14 ceramic cement, a highly durable insulation means, and the use
15 of connector pins, provides protection against shortage and
16 other connection damage not previously possible. Such an
17 improvement is of great significance as the internal
18 connection for a down hole heating unit must be impenetrably
19 shielded from the pressures and hostile chemical agents that
20 surround the unit in the well bore.

Referring in combination to Figures 1 and 2, heating unit 20 includes heating unit connector 30. Heating unit connector 30 is responsible for ensuring the integrity of the connection between surface wiring leads 24 and heater rod wiring leads 25. The electrical current for heater rod 26 is supplied by cables 22, which run down the exterior of production tubing 12 and connect to surface wiring leads 24 at the upper end of heating unit 20.

As shown in Figure 2, heating unit connector 30 is comprised of two substantially identical pieces. The upper piece, generally referred to by numeral 32, houses surface wiring leads 24. The lower piece, generally referred to by numeral 34, houses heater wiring 26.

Heater unit connector 30 also contains two connector pins (male and female), where each connector pin has a distal and a medial end. The union between male connector pin 40 and female connector pin 42 takes place at the medial end of each connector piece, or at the center-most portion of heater unit connector 30. Male connector pin 40, at its distal end, has a female receptacle that receives a male connection from

1 heater wiring leads 25. At its medial end, male connector pin
2 40 has a male extension that is plugged into the medial end of
3 female connector pin 42.

4
5 Female connector pin 42 contains female receptacles at
6 both its medial and distal end. At its distal end, female
7 connector pin 42 receives a male connection from surface
8 wiring leads 24. At its medial end, female connector pin 42
9 receives male connector pin 40. Importantly, the improvements
10 provided by the present invention do not depend on any
11 specific connector pin configuration. In fact, as will become
12 apparent to those skilled in the art, different connector pin
13 configurations or different connector pin types may work
14 equally as well.

15
16 Connector pieces 32 and 34 each contain, in their distal
17 portion, a high temperature ceramic cement filled region,
18 generally designated by numeral 36. The ceramic cement of
19 region 36 serves to enclose the junction between each
20 connector pin and the respective wiring of each piece. In the
21 preferred embodiment, the high temperature ceramic cement is
22 an epoxy material which is available as Sauereisen Cement #1,

1 which may be obtained from the Industrial Engineering and
2 Equipment Company ("Indeeco") of St. Louis, Missouri, USA.)
3 However, as will become apparent to those skilled in the art,
4 other materials may serve to perform the desired function.

5
6 Upon drying, the high temperature ceramic cement of
7 region 36 becomes an essentially glass-like substance.
8 Shrinkage is associated with the cement as it dries. As such,
9 in the preferred embodiment, each heater unit connector piece
10 contains a pipe plug 38. Pipe plug 38 provides an access
11 point through which additional ceramic cement can be injected
12 into each piece, thereby filling any void which develops as
13 the ceramic cement dries. Further, pipe plug 38 may be
14 reversibly sealed to each piece so that epoxy can be injected
15 as needed while the strength of the seal is maintained.

16
17 Connector pieces 32 and 34 further contain, in the medial
18 portion, an insulator block region, generally designated by
19 numeral 39. Insulator region 39 houses each connector pin so
20 that the union between male connector pin 40 and female
21 connector pin 42 is suitably insulated from any outside
22 chemical or electrical agent.

1 In order to withstand the corrosive chemicals and
2 enormous external pressure, the outer surface of heater unit
3 connector 30 must be incredibly strong. The aforementioned
4 elements of connector 30 are encased in a steel fitting
5 assembly 50 ("encasement means"), each component of which is
6 welded with continuous beads, using the "TEG" welding process,
7 to each adjoining component. In the preferred embodiment, the
8 outer surface of connector 30 is comprised of stainless steel,
9 which is joined using the process of "TEG" welding. This
10 welding process allows the seams of joined components to
11 withstand the extreme conditions of the bore well.
12

13 Finally, each connector piece is secured to the other by
14 fitting assembly 60. Fitting assembly 60 and sealing fitting
15 62 are, as would be apparent to anyone skilled in the art,
16 designed to engage one another so as to form a sealed
17 junction. In the preferred embodiment, this union is a
18 standard two inch union that is modified by "TEG" welding.
19 That is, the union is welded using the TEG process so that it
20 will withstand the extreme environmental conditions of the
21 bore well.
22

1 The shielding of the electrical connections between
2 surface wiring leads 24 and heater wiring leads 25 is crucial
3 for long-term operation of a down hole heating system of the
4 present invention. Equally important is that power is
5 reliably delivered to that connection. Therefore, solid
6 copper leads with KAPTON insulation are used, such leads being
7 of a suitable gauge for carrying the intended 16.5 Kilowatt,
8 480 volt current for the present system with its .475 inch
9 diameter INCOLOY heater rods 26 (also available from Indeeco).

10
11 The present invention includes the method for use of the
12 above-described system for heat treating an oil or gas well
13 for improving well flow. the method would be one which
14 included use of a down hole heating unit with suitably
15 shielded electrical connections substantially as described,
16 along with installation of the heat-retaining elements also as
17 described to properly focus heat on the producing formation.

18
19 In addition to the foregoing, it should be understood
20 that the present method may also be utilized by substituting
21 cable ("wire line") for the down hole pipe for supporting the
22 heating unit 20 while pipe is pulled from the well bore. In

1 other words, one can heat-treat a well using the presently
2 disclosed apparatuses and their equivalents before re-
3 inserting pipe, such as during other well treatments or
4 maintenance during which pipe is pulled. It is believed that
5 this approach would be particularly beneficial in treating
6 deep gas wells with iron sulfide occlusion problems.

7
8 Although the invention has been described with reference
9 to specific embodiments, this description is not meant to be
10 construed in a limited sense. Various modifications of the
11 disclosed embodiments, as well as alternative embodiments of
12 the inventions will become apparent to persons skilled in the
13 art upon reference to the description of the invention. It
14 is, therefore, contemplated that the appended claims will
15 cover such modifications that fall within the scope of the
16 invention.